Peer-to-peer

10/609,325 RCE Exhibit B

From Wikipedia, the free encyclopedia

P2P redirects here. For other uses, see P2P (disambiguation) or Peer-to-peer (disambiguation).

A **peer-to-peer** (or "**P2P**") computer network relies primarily on the computing power and bandwidth of the participants in the network rather than concentrating it in a relatively low number of servers. Peer-to-peer networks are typically used for connecting nodes via largely *ad hoc* connections. Such networks are useful for many purposes. Sharing content files (see file sharing) containing audio, video, data or anything in digital format is very common, and realtime data, such as telephony traffic, is also passed using P2P technology.

A pure peer-to-peer network does not have the notion of clients or servers, but only equal *peer* nodes that simultaneously function as both "clients" and "servers" to the other nodes on the network. This model of network arrangement differs from the client-server model where communication is usually to and from a central server. A typical example for a non peer-to-peer file transfer is an FTP server where the client and server programs are quite distinct, and the clients initiate the download/uploads and the servers react to and satisfy these requests.

The earliest peer-to-peer network in widespread use was the Usenet news server system, in which peers communicated with one another to propagate Usenet news articles over the entire Usenet network. Particularly in the earlier days of Usenet, UUCP was used to extend even beyond the Internet. However, the news server system also acted in a client-server form when individual users accessed a local news server to read and post articles. The same consideration applies to SMTP email in the sense that the core email relaying network of Mail transfer agents is a peer-to-peer network while the periphery of Mail user agents and their direct connections is client server.

Some networks and channels such as Napster, OpenNAP and IRC server channels use a client-server structure for some tasks (e.g. searching) and a peer-to-peer structure for others. Networks such as Gnutella or Freenet use a peer-to-peer structure for all purposes, and are sometimes referred to as true peer-to-peer networks, although Gnutella is greatly facilitated by directory servers that inform peers of the network addresses of other peers.

Peer-to-peer architecture embodies one of the key technical concepts of the internet, described in the first internet Request for Comments, RFC 1, "Host Software" dated 7 April 1969. More recently, the concept has achieved recognition in the general public in the context of the absence of central indexing servers in architectures used for exchanging multimedia files.

The concept of peer to peer is increasingly evolving to an expanded usage as the relational dynamic active in distributed networks, i.e. not just computer to computer, but human to human. Yochai Benkler has coined the term "commons-based peer production" to denote collaborative projects such as free software. Associated with peer production are the concept of peer governance (referring to the manner in which peer production projects are managed) and peer property (referring to the new type of licenses which recognize individual authorship but not exclusive property rights, such as the GNU General Public License and the Creative Commons License).

Contents

Classification of peer-to-peer networks

One possible classification of peer-to-peer networks is according to their degree of centralization:

Pure peer-to-peer:

- Peers act as equals, merging the roles of clients and server
- There is no central server managing the network
- There is no central router

Hybrid peer-to-peer:

- Has a central server that keeps information on peers and responds to requests for that information.
- Peers are responsible for hosting available resources (as the central server does not have them), for letting the central server know what resources they want to share, and for making its shareable resources available to peers that request it.
- Route terminals are used addresses, which are referenced by a set of indices to obtain an absolute address.

Some examples of pure peer-to-peer application layer networks designed for file sharing are Gnutella and Freenet.

Meanwhile some may also categorize peer-to-peer networks into the following categories:

- Centralized P2P network such as Napster
- Decentralized P2P network such as KaZaA
- Structured P2P network such as CAN
- Unstructured P2P network such as Gnutella
- Hybrid P2P network (Centralized and Decentralized) such as JXTA, GreenTea and Shwup

Advantages of peer-to-peer networks

An important goal in peer-to-peer networks is that all clients provide resources, including bandwidth, storage space, and computing power. Thus, as nodes arrive and demand on the system increases, the total capacity of the system also increases. This is not true of a client-server architecture with a fixed set of servers, in which adding more clients could mean slower data transfer for all users.

The distributed nature of peer-to-peer networks also increases robustness in case of failures by replicating data over multiple peers, and -- in pure P2P systems -- by enabling peers to find the data without relying on a centralized index server. In the latter case, there is no single point of failure in the system.

When the term peer-to-peer was used to describe the Napster network, it implied that the peer protocol was important, but, in reality, the great achievement of Napster was the empowerment of the peers (i.e., the fringes of the network) in association with a central index, which made it fast and efficient to locate available content. The peer protocol was just a common way to achieve this.

Unstructured and structured P2P networks

The P2P overlay network consists of all the participating peers as network nodes. There are links between any two nodes that know each other: i.e. if a participating peer knows the location of another peer in the P2P network, then there is a directed edge from the former node to the latter in the overlay network. Based on how the nodes in the overlay network are linked to each other, we can classify the P2P networks as unstructured or structured.

An unstructured P2P network is formed when the overlay links are established arbitrarily. Such networks can be easily constructed as a new peer that wants to join the network can copy existing links of another node and then form its own links over time. In an unstructured P2P network, if a peer wants to find a desired piece of data in the network, the query has to be flooded through the network to find as many peers as possible that share the data. The main disadvantage with such networks is that the queries may not always be resolved. Popular content is likely to be available at several peers and any peer searching for it is likely to find the same thing, but if a peer is looking for rare data shared by only a few other peers, then it is highly unlikely that search will be successful. Since there is no correlation between a peer and the content managed by it, there is no guarantee that flooding will find a peer that has the desired data. Flooding also causes a high amount of signalling traffic in the network and hence such networks typically have very poor search efficiency. Most of the popular P2P networks such as Gnutella and FastTrack are unstructured.

Structured P2P networks employ a globally consistent protocol to ensure that any node can efficiently route a search to some peer that has the desired file, even if the file is extremely rare. Such a guarantee necessitates a more structured pattern of overlay links. By far the most common type of structured P2P network is the distributed hash table (DHT), in which a variant of consistent hashing is used to assign ownership of each file to a particular peer, in a way analogous to a traditional hash table's assignment of each key to a particular array slot. Some well known DHTs are Chord, Pastry, Tapestry, CAN, and Tulip. Not a DHT-approach but a structured P2P network is HyperCuP.

Legal controversy

Further information: EU Copyright Directive

Under US law "the Betamax decision" (Sony Corp. of America v. Universal City Studios, Inc.), case holds that copying "technologies" are not *inherently* illegal, if substantial non-infringing use can be made of them. This decision, predating the widespread use of the Internet applies to most data networks, including peer-to-peer networks, since legal distribution of some files can be performed. These non-infringing uses include sending open source software, creative commons works and works in the public domain. Other jurisdictions tend to view the situation in somewhat similar ways.

In practice, many, often most, of the files shared on peer-to-peer networks are copies of copyrighted popular music and movies. Sharing of these copies among strangers is illegal in most jurisdictions. This has led many observers, including most media companies and some peer-to-peer critics, to conclude that the networks themselves pose grave threats to the established distribution model. The research that attempts to measure actual monetary loss has been somewhat equivocal. Whilst on paper the existence of these networks results in large losses, the actual income does not seem to have changed much since these networks started up. Whether the threat is real or not, both the RIAA and the MPAA now spend large amounts of money attempting to lobby lawmakers for the creation of new laws, and some copyright owners pay companies to help legally challenge users engaging in illegal sharing of their material.

In spite of the Betamax decision, peer-to-peer networks themselves have been targeted by the representatives of those artists and organizations who license their creative works, including industry trade organizations such as the RIAA and MPAA as a potential threat. The Napster service was shut down by an RIAA lawsuit.

In *A&M Records v. Napster*, 239 F.3d 1004 (9th Cir. 2001), the court found that Napster was both vicariously and contributorily liable for the copyright infringement its users were engaged in. Vicarious liability in these types of cases extends to a provider who financially benefits from the infringement committed by its users while having the ability to police that infringement but has failed to do so. The court found ample evidence that Napster's future revenue is directly dependent upon "increases in userbase." It also found that Napster could have done more than it claimed with regards to restricting users from sharing copyrighted material. Later on in the opinion, the famous peer-to-peer provider was also found contributorily liable. It knew of the infringing use that Napster could and did have, in a medium where the software provided essential access. The RIAA could have sued individual users at the time for violating federal law, but thought it more prudent to shut down the means by which those users shared music.

Napster's use of a central server distinguishes it, on its facts, from the next generation peer-to-peer technology, in which the communication of files is truly "peer to peer." Therefore, additional litigation was needed to determine the legality of their uses.

In *MGM v. Grokster*, the U.S. Supreme Court reversed a decision of the Ninth Circuit Court of Appeals which had granted a summary judgment of dismissal, and held that there were factual issues concerning whether the defendant p2p software providers had, or had not, encouraged their users to infringe copyrights. If they had done so, they could be held liable for secondary copyright infringement.

The main point of the Grokster holding was about "inducement." "The classic case of direct evidence of unlawful purpose occurs when one induces commission of infringement by another, or "entic[es] or persuad[es] another" to infringe, Black's Law Dictionary 790 (8th ed. 2004), as by advertising. Thus at common law a copyright or patent defendant who "not only expected but invoked [infringing use] by advertisement" was liable for infringement ..." The court noted that simply providing the material was

not enough. While the decision did not find liability, it simply laid out the groundwork for how the law should be interpreted.

A little over a year later, the RIAA initiated the first major post-Grokster case, *Arista v. Limewire*, in Manhattan federal court. Lime Wire has counterclaimed in that suit, charging the major record companies with antitrust violations and other misconduct."Lime Wire Sues RIAA for Antitrust Violations"

Shortly thereafter, the lower court judge in *Grokster* found one of the defendants, Streamcast, the maker of Morpheus, to be liable under the standards enunciated by the Supreme Court. "Streamcast Held Liable for Copyright Infringement in MGM v. Grokster, Round 2" ("Recording Industry vs. The People")

The foregoing cases dealt with 'secondary liability' under the Copyright Act, i.e. whether and when the p2p network software providers can be held liable for 'primary' infringement by their customers. Meanwhile, the underlying question of what uses those customers can make of p2p software without committing a primary infringement is a matter just beginning to be explored, most notably in litigations brought by the Motion Picture Association of America (MPAA) and the Recording Industry Association of America (RIAA) against p2p customers.

In *Elektra v. Barker*[1], an RIAA case against Tenise Barker, a Bronx nursing student, Ms. Barker moved to dismiss the complaint, contending, among other things, that the RIAA's allegation of "making available" did not state any known claim under the Copyright Act.[2][3]. The RIAA countered with the argument that "making available" is a copyright infringement, even though the language does not appear in the Act.[4]. Thereafter, several *amicus curiae* were permitted to file briefs in the case, including the MPAA, which agreed[5] with the RIAA's argument, and the Electronic Frontier Foundation (EFF), the U.S. Internet Industry Association (USIIA), and the Computer & Communications Industry Association (CCIA), which agreed with Ms. Barker.[6][7] The US Department of Justice submitted a brief refuting one of the arguments made by EFF,[8] but did not take any position on the RIAA's "making available" argument[9]. The *Elektra v. Barker* case was argued before Judge Kenneth M. Karas in Manhattan federal court on January 26, 2007, and as of this writing is awaiting decision.

Anonymous peer-to-peer networks allow for distribution of material - legal or not - with little or no legal accountability across a wide variety of jurisdictions. Some observers contend this will lead to more trading of illegal material, and call for regulation on these grounds [10]. Others state that the presumption of innocence must apply, and that non peer-to-peer technologies like e-mail (for which there are also anonymizing services), have similar capabilities. Further, the potential for illegal uses should not prevent the technology from being used for legal purposes.

In the European Union (EU), the 2001 EU Copyright directive, which implemented the 1996 WIPO treaty ("World Intellectual Property Organization Copyright Treaty"), prohibits peer-to-peer, claiming it is a violation of the directive. However, not all European member states have implemented the directive in national legislation. Notably, on December 22, 2005, after discussing the EU directive, the French parliament passed two amendments legalizing the exchange of copies on the internet for private use. In a later proceeding, the French government withdrew the article in question and made illegal any p2p client obviously aimed at sharing copyrighted material. The term "obviously" was not defined. The project of law (called DADVSI) has still to be discussed by the French senate and, if the decision differs too much from the Parliament's, it will be debated on second lecture back at the Parliament (Assemblée Nationale).

Interestingly, Canada stands out by authorizing, at least until the projected copyright reform, downloads on peer-to-peer networks under the "private copying" exception.

Important Cases

- US law
  - Sony Corp. v. Universal City Studios (The Betamax decision)
  - MGM v. Grokster
  - Metallica v. Napster (never went to court)

- Australia
  - Universal Music Australia v Sharman Licence Holdings 2005 FCA 1242(5 September 2005) (the Kazaa case)

Computer science perspective

Technically, a completely pure peer-to-peer application must implement only peering protocols that do not recognize the concepts of "server" and "client". Such *pure* peer applications and networks are rare. Most networks and applications described as peer-to-peer actually contain or rely on some non-peer elements, such as DNS. Also, real world applications often use multiple protocols and act as client, server, and peer simultaneously, or over time. Completely decentralized networks of peers have been in use for many years: two examples are Usenet (1979) and FidoNet (1984).

Many P2P systems use stronger peers (super-peers, super-nodes) as servers and client-peers are connected in a star-like fashion to a single super-peer.

Sun added classes to the Java technology to speed the development of peer-to-peer applications quickly in the late 1990s so that developers could build decentralized real time chat applets and applications before Instant Messaging networks were popular. This effort is now being continued with the JXTA project.

Peer-to-peer systems and applications have attracted a great deal of attention from computer science research; some prominent research projects include the Chord project, the PAST storage utility, the P-Grid, a self-organized and emerging overlay network and the CoopNet content distribution system (see below for external links related to these projects).

Application of P2P Network outside Computer Science

- Bioinformatics:Peer-to-peer networks have also begun to attract attention from scientists in other disciplines, especially those that deal with large datasets such as bioinformatics. P2P networks can be used to run large programs designed to carry out tests to identify drug candidates. The first such program was begun in 2001 the Centre for Computational Drug Discovery at Oxford University in cooperation with the National Foundation for Cancer Research. There are now several similar programs running under the auspices of the United Devices Cancer Research Project. On a smaller scale, a self-administered program for computational biologists to run and compare various bioinformatics software is available from Chinook.

- Education and Academic: Due to the fast distribution and large storage space features, many organizations are trying to apply P2P network for educational and academic purposes. For instance, Pennsylvania State University, MIT and Simon Fraser University are carrying on a project called LionShare designed for facilitating file sharing among educational institutions globally.

- Military: The U.S. Department of Defense has already started research topic on P2P network as part of its modern network war. In May, 2003 Dr. Tether. Director of Defense Advanced Research Project Agency has testified that U.S. Military is using P2P network. Due to security reasons, many files are still kept in confidential.

- Business: P2P network has already been used in business areas, but it is still at the beginning line. Currently, Kato et al's studies indicate over 200 companies with approximately $400 million USD are investing in P2P network. Besides File Sharing, companies are also interested in Distributing Computing, Content Distribution, e-market place, Distributed Search engines, Groupware and Office Automation via P2P network. There are several reasons why companies prefer P2P sometimes such as: Real-time collaboration, a server cannot manage with increasing volume of contents, a process requires strong computing power, a process needs high-speed communications etc. At the same time, P2P is not fully used as it still confronts a lot of security issues.

- TV

- Telecommunication: Nowadays, people are not just satisfied with "can hear a person from another side of the earth", instead, the demands of clearer voice in real-time are increasing globally. Just like the TV network, there are already cables built. It's not very likely for companies to change all the cables. Many of them turn to use internet, more specifically, P2P network. For instance, Skype, one of the most widely used phone software is using P2P technology. Furthermore, many research organizations are trying to apply P2P network on cellular network.

Attacks on peer-to-peer networks

Many peer-to-peer networks are under constant attack by people with a variety of motives.

Examples include:

- poisoning attacks (e.g. providing files whose contents are different from the description)
- polluting attacks (e.g. inserting "bad" chunks/packets into an otherwise valid file on the network)
- defection attacks (users or software that make use of the network without contributing resources to it)
- insertion of viruses to carried data (e.g. downloaded or carried files may be infected with viruses or other malware)
- malware in the peer-to-peer network software itself (e.g. distributed software may contain spyware)
- denial of service attacks (attacks that may make the network run very slowly or break completely)
- filtering (network operators may attempt to prevent peer-to-peer network data from being carried)
- identity attacks (e.g. tracking down the users of the network and harassing or legally attacking them)
- spamming (e.g. sending unsolicited information across the network- not necessarily as a denial of service attack)

Most attacks can be defeated or controlled by careful design of the peer-to-peer network and through the use of encryption. P2P network defense is in fact closely related to the "Byzantine Generals Problem". However, almost any network will fail when the majority of the peers are trying to damage it, and many protocols may be rendered impotent by far fewer numbers.

Networks, protocols and applications

Network or Protocol	Applications
Ares	Ares Galaxy, Warez P2P, Filecroc
BitTorrent	ABC, AllPeers, Azureus, BitComet, BitLord, BitSpirit, BitTornado, BitTorrent, Burst!, FlashGet, G3 Torrent, Halite, KTorrent, MLDonkey, mlMac, Opera, QTorrent, Shareaza, Transmission, Tribler, µTorrent
CSpace	a peer-to-peer based communications system
Direct Connect	DC++, NeoModus Direct Connect, BCDC++, ApexDC++, StrongDC++
Domain Name System	
eDonkey	aMule, eDonkey2000 (discontinued), eMule, eMule Plus, Hydranode, Jubster, lMule, Lphant, MLDonkey, mlMac, Morpheus, Pruna, Shareaza, xMule, iMesh
FastTrack	giFT, Grokster, iMesh (and its variants stripped of adware including iMesh Light), Kazaa (and its variants stripped of adware such as Kazaa Lite), KCeasy, Mammoth, MLDonkey, mlMac, Poisoned
Freenet	Entropy (on its own network), Freenet
GNUnet	GNUnet, (GNUnet-gtk)
Gnutella	Acquisition, BearShare, Cabos, Gnucleus, Grokster, iMesh, gtk-gnutella, Kiwi Alpha, LimeWire, FrostWire, MLDonkey, mlMac, Morpheus, Phex, Poisoned, Swapper, Shareaza, XoloX
Gnutella2	Adagio, Caribou, Gnucleus, iMesh, Kiwi Alpha, MLDonkey, mlMac, Morpheus, Shareaza, TrustyFiles
Kad Network	aMule, eMule, MLDonkey
MANOLITO/MP2P	Blubster, Piolet
Krawler	Krawler[x]
MFPnet	Amicima
Napster	Napigator, OpenNap, WinMX
P2PTV	TVUPlayer, Joost, CoolStreaming, Cybersky-TV, TVants, PPLive
Peercasting	PeerCast, IceShare, FreeCast, PeerStream, Rawflow
Retroshare	Retroshare serverless Filesharing with Chat Messenger
Usenet	see list of news clients
Windows Peer-to-Peer	Advanced Networking Pack for Windows XP,Windows XP SP2, Windows Vista (This is a Windows component that provides a 'meta' peer-to-peer network that applications can piggyback)
WPNP	WinMX

- Other networks: Alliance, ANts P2P, Applejuice, Audiogalaxy, Avalanche, CAKE, Chord, The Circle, Coral, Dijjer, EarthStation 5, FileTopia, Groove, Hamachi, iFolder, konspire2b, Madster/Aimster, MUTE, OpenFT, P-Grid, IRC, JXTA, KoffeePhoto, MojoNation, Mnet, Octoshape, Omemo, Overnet, Peersites, Perfect Dark, Scour, Skype, Solipsis, soribada, Soulseek, SPIN, Swarmcast, WASTE, Winny

An earlier generation of peer-to-peer systems were called "metacomputing" or were classed as "middleware". These include: Legion, Globus

Multi-network applications

Applications	Network or Protocol	Operating systems	License
aMule	eDonkey network, Kad network	Cross-platform	GPL
eMule	eDonkey network, Kad network	Windows	GPL
FileScope	eDonkey network, Gnutella, Gnutella2, OpenNAP	Cross-platform	GPL
giFT	eDonkey network, FastTrack, Gnutella	Cross-platform	GPL
Gnucleus	Gnutella, Gnutella2	Windows	GPL
iMesh	FastTrack, eDonkey network, Gnutella, Gnutella2	Windows	
KCeasy	Ares, FastTrack, Gnutella, OpenFT	Windows	GPL
Kiwi Alpha	Gnutella, Gnutella2	Windows	
MLDonkey	BitTorrent, Direct Connect, eDonkey network, FastTrack, Gnutella, Gnutella2, Kad Network, OpenNap, SoulSeek, HTTP/FTP	Cross-platform	GPL
Morpheus	NEO Network, Gnutella, Gnutella2, BitTorrent	Windows	
Napshare	Key network, MUTE network	Linux, Windows	GPL
Shareaza	BitTorrent, eDonkey, Gnutella, Gnutella2	Windows	GPL
Zultrax	Gnutella, ZEPP	Windows	

See also

- Ambient network
- Anonymous P2P
- Privacy of the Gnutella Protocol
- Byzantine Fault Tolerance
- Client-server
- Comparison of P2P applications
- Compulsory licensing
- Computer cluster
- Distributed hash table
- File sharing
- Friend-to-friend (or F2F)
- Friend-to-friend with third party storage
- Grid computing
- Overlay network
- Servent

- Swarm intelligence
- ad hoc network

External links

- Various Papers(Research & Practical) on P2P (GOBO)
- P2P Networking 4 Science A review of the current and potential uses of peer-to-peer networks in scientific research
- Annual IEEE International Conference on peer-to-Peer Computing
- Conferences and Resources on peer-to-peer computing
- IBM Developer Works: The practice of peer-to-peer computing
- Internet2® peer-to-Peer Working Group
- Microsoft peer-to-peer networking
- OpenP2P peer-to-peer development resources
- The Foundation for P2P Alternatives Wiki-based site with discussion of the philosophy behind peer-to-peer networks
- Introduction to Windows Peer-to-Peer Networking from MSDN.
- Study: P2P effect on legal music sales "not statistically distinguishable from zero"

References

1. ^ Elektra v. Barker
2. ^ Elektra v. Barker, Memorandum of Law in Support of Motion to Dismiss Complaint
3. ^ Reply Memorandum of Law in Support of Motion to Dismiss Complaint
4. ^ Elektra v. Barker, Plaintiffs' Memorandum of Law in Opposition to Dismissal Motion
5. ^ Amicus Curiae brief of MPAA
6. ^ Amicus Curiae brief of EFF
7. ^ Amicus Curiae brief of USIIA and CCIA
8. ^ Statement of Interest of U.S. Department of Justice
9. ^ Statement of Interest, page 5, footnote 3
10. ^ http://news.bbc.co.uk/2/hi/programmes/newsnight/4758636.stm

- Ross J. Anderson. The eternity service. In *Pragocrypt 1996*, 1996.
- Marling Engle & J. I. Khan. Vulnerabilities of P2P systems and a critical look at their solutions, May 2006

- Stephanos Androutsellis-Theotokis and Diomidis Spinellis. A survey of peer-to-peer content distribution technologies. ACM Computing Surveys, 36(4):335–371, December 2004. doi:10.1145/1041680.1041681.

- Biddle, Peter, Paul England, Marcus Peinado, and Bryan Willman, The Darknet and the Future of Content Distribution. In *2002 ACM Workshop on Digital Rights Management*, 18 November 2002.

- Antony Rowstron and Peter Druschel, Pastry: Scalable, Decentralized Object Location, and Routing for Large-Scale Peer-to-Peer Systems. In proceedings *Middleware 2001 : IFIP/ACM International Conference on Distributed Systems Platforms*. Heidelberg, Germany, November 12-16, 2001. Lecture Notes in Computer Science, Volume 2218, Jan 2001, Page 329.

- Andy Oram et al., Peer-to-Peer:Harnessing the Power of Disruptive Technologies, Oreilly 2001

- Detlef Schoder and Kai Fischbach, Core Concepts in Peer-to-Peer (P2P) Networking. In: Subramanian, R.; Goodman, B. (eds.): P2P Computing: The Evolution of a Disruptive Technology, Idea Group Inc, Hershey.
- I. Stoica, R. Morris, D. Karger, M. F. Kaashoek, and H. Balakrishnan. Chord: A scalable peer-to-peer lookup service for internet applications. In *Proceedings of SIGCOMM 2001*, August 2001.
- Ralf Steinmetz, Klaus Wehrle (Eds). Peer-to-Peer Systems and Applications. ISBN 3-540-29192-X, Lecture Notes in Computer Science, Volume 3485, Sep 2005
- Shuman Ghosemajumder. Advanced Peer-Based Technology Business Models. *MIT Sloan School of Management, 2002.*
- Silverthorne, Sean. *Music Downloads: Pirates- or Customers?*. Harvard Business School Working Knowledge, 2004.

Categories: Computer networking articles needing expert attention | File sharing networks | Distributed data sharing | Electronic commerce